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# **CHEMOSTERILANTS SCREENED AGAINST THE BOLL WEEVIL IN DIPPING AND FEEDING TESTS**

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# CHEMOSTERILANTS SCREENED AGAINST THE BOLL WEEVIL IN DIPPING AND FEEDING TESTS

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Ninety-eight candidate compounds were screened during 1969 in the Boll Weevil Research Laboratory at State College, Miss., against the adult boll weevil (*Anthonomus*

*grandis* Boheman) to determine their effectiveness as chemosterilants in dipping and feeding tests.

## MATERIALS AND METHODS

With the exception of four compounds from a chemical company, all compounds were supplied by the Pesticide Chemicals Research Branch, Entomology Research Division, Beltsville, Md., and the Southern Research Institute, Birmingham, Ala.

A laboratory culture of boll weevils was used in the screening program. The larval and adult diets<sup>2,3</sup> were prepared daily for use.

In the dipping tests, the newly emerged (0–24 hours) adult weevils were dipped once for 15 seconds in water (H<sub>2</sub>O) and for 5 seconds in methanol (MeOH), dimethyl sulfoxide (DMSO), or acetone and allowed to dry. In the feeding tests, the compounds were incorporated into the

hot adult diet, then made into pellets, and given to the weevils for 3 days. Twenty-five weevils of each sex were used in each test. They were placed in containers and mated with equal numbers of untreated weevils. Following treatment all test insects were held at 30° C. and fed regular adult diet pellets, which were changed daily.

Egg and mortality counts were made 7 and 14 days after treatment. Half the eggs collected, usually a sample of 50, were implanted on larval medium and the other half were placed on wet filter paper and observed daily up to 7 days for hatch. The egg hatch and emergence data were calculated by dividing the test percent by the control percent and multiplying by 100; however, the test percent was never shown to be more than 100. The mortality was derived by subtracting the control mortality from the test mortality, but the test percent was never shown to be less than 0.

Three criteria of effectiveness were arbitrarily selected and the compounds were tabulated according to these criteria. Table 1 includes compounds that reduced adult emergence to 33 percent or less (effective), from 33 to 66 percent (intermediate), and from 66 to 100 percent (ineffective).

<sup>1</sup> The authors acknowledge the assistance of Mrs. Marie Osborne, of this Division, who reviewed the chemical names, and O. H. Lindig, of the Boll Weevil Research Laboratory, for supplying weevils and diets for test purposes.

<sup>2</sup> VANDERZANT, E. S., and DAVICH, T. B. LABORATORY REARING OF THE BOLL WEEVIL. A SATISFACTORY LARVAL DIET AND OVIPOSITION STUDIES. Jour. Econ. Ent. 51: 288–291. 1958.

<sup>3</sup> GAST, R. T. MASS PRODUCING ARTIFICIAL DIET PELLETS FOR ADULT BOLL WEEVILS. Jour. Econ. Ent. 58: 1024–1025. 1965.

## RESULTS AND DISCUSSION

Twenty-nine compounds tested against males and females in dipping and feeding tests at various concentrations reduced adult emergence to 33 percent or less. Thirteen of these compounds reduced adult emergence or fecundity to 0 when tested on males and females; however, mortality was high (>25 percent) for all except 2-pyridinethiol 1-oxide sodium salt (ENT-22596), tretamine (ENT-25296), and hempa (ENT-50882).

2-Pyridinethiol 1-oxide sodium salt and tretamine in dipping tests at 1 and 1.5 percent, respectively, reduced egg laying of treated females to 0 and mortality was 0 and 22 percent, respectively, after 14 days (table 1). Thus 2-pyridinethiol 1-oxide sodium salt and tretamine were the most effective and least toxic compounds tested on females. Hempa was a moderately effective sterilant on males in dipping tests at concentrations of 5, 10, 25, and 50 percent.<sup>4</sup> When hempa was fed to males for 3 days at 0.15 and 0.2 percent, adult emergence was reduced to 0 and mortality was 25 and 5 percent, respectively, after 14 days (table 1). Hempa was the only male sterilant tested that reduced adult emergence to 0, and mortality was 25 percent or less after 14 days.

Forty compounds tested on males and females demonstrated intermediate effectiveness (reduced emergence to 33–66 percent). 2-Methyl-*p*-benzoquinone (ENT-14931) and hempa (ENT-50882) when fed to females at concentrations of 1 and 0.15 percent, respectively, reduced emergence to 34 and 39 percent. Mortality was 0 and 15 percent, respectively, after 14 days. (*E*)-*N,N'*-vinylenebis(1-aziridinecarboxamide) (ENT-50987) and 4-(*o*-tolylazo)-*o*-toluidine (ENT-52505) when tested on males, at 2 and 1 percent, respectively, reduced adult emergence to 36 and 35 percent with no adult mortality after 14 days. These four compounds, and many others reducing emergence to 0–33 percent warrant further testing.

The least effective compounds, 76 in all, reduced emergence to 66–100 percent. Mortality of treated weevils was low in most of these tests. Although the most effective sterilizing compounds are listed under those reducing emergence to 0–33 percent, they were generally the most toxic to the weevil; however, 2-pyridinethiol 1-oxide sodium salt, tretamine, and hempa were the most effective sterilants in overall dipping and feeding tests where toxicity was low.

## SUMMARY

Ninety-eight candidate chemosterilants were tested against the adult boll weevil (*Anthonomus grandis* Boheman) in dipping and feeding tests at various concentrations. 2-Pyridinethiol

1-oxide sodium salt and tretamine in dipping tests at 1 and 1.5 percent reduced egg laying of treated females to 0 and mortality was 0 and 22 percent, respectively, after 14 days. Hempa when fed to males at 0.15 and 0.2 percent reduced adult emergence to 0 and mortality was 25 and 5 percent, respectively, after 14 days.

<sup>4</sup> HAYNES, J. W., HEDIN, P. A., and DAVICH, T. B. HEMPA AND APHOLATE AS CHEMOSTERILANTS FOR THE BOLL WEEVIL. Jour. Econ. Ent. 59: 1014–1015. 1966.



TABLE 1.—Relative effectiveness of candidate chemosterilants on boll weevil hatch, adult emergence, and mortality in dipping and feeding tests. (1 replication of 25 pairs of weevils per test)

Entomology No. (ENT-)	Chemical and concentration (percent)	Solvent	Test and sex treated	Average hatch	Average adult emergence	Mortality after 14 days
EMERGENCE REDUCED TO 0-33 PERCENT						
				Percent	Percent	Percent
2546	Furil, 2	MeOH	Dip M <sup>1</sup>	100	32	2
15229	Anthranilic acid, 5-chloro-, 2	MeOH	Dip F	86	20	0
22596	2-Pyridinethiol, 1-oxide, sodium salt:					
1	.....	H <sub>2</sub> O	Dip F	(2)	...	0
2	.....	MeOH	Dip M	0	0	38
2	.....	MeOH	Dip F	(2)	...	42
.5	.....	.....	Fed M	0	...	64
.5	.....	.....	Fed F <sup>3</sup>	(2)	...	64
24915	Phosphine oxide, tris(1-aziridinyl)-:					
2	.....	H <sub>2</sub> O	Dip M	0	0	46
2	.....	H <sub>2</sub> O	Dip F	(2)	...	54
25012	1,4-Butanediol, dimethanesulfonate:					
0.1	.....	.....	Fed M	0	0	88
.1	.....	.....	Fed F	(2)	...	80
.25	.....	.....	Fed M	0	0	88
.25	.....	.....	Fed F	(2)	...	76
.5	.....	.....	Fed M	0	0	88
.5	.....	.....	Fed F	(2)	...	88
25296	s-Triazine, 2,4,6-tris(1-aziridinyl)- (tretamine):					
1.5	.....	H <sub>2</sub> O	Dip M	0	0	38
1.5	.....	H <sub>2</sub> O	Dip F	54	0	22
10	.....	H <sub>2</sub> O	Dip M	0	0	68
10	.....	H <sub>2</sub> O	Dip F	0	0	80
26685	Triethylamine, 2"-chloro-1,1'-dimethyl-, monohydrochloride, 0.1	.....	Fed F	0	0	62
34254	3,7-Tetradecadien-2-one,11,12-epoxy-8-ethyl-4,12-dimethyl-(mixed isomers), 0.7	.....	Fed F	100	33	14

See footnotes at end of table.

TABLE 1.—Relative effectiveness of candidate chemosterilants on boll weevil hatch, adult emergence, and mortality in dipping and feeding tests. (1 replication of 25 pairs of weevils per test)—Continued

Entomology No. (ENT-)	Chemical and concentration (percent)	Solvent	Test and sex treated	Average hatch	Average adult emergence	Mortality after 14 days
				Percent	Percent	Percent
50466	Acetohydroxamic acid, <i>N</i> -fluoren-2-yl-: 0.0625..... .125.....	..... .....	Fed F..... Fed F.....	100 (2)	0 ...	66 86
50761	Phosphinic acid, bis(1-aziridinyl)-, ethyl ester, 2.....	H <sub>2</sub> O.....	Dip F.....	(2)	...	92
50781	Urea, 1-[bis(1-aziridinyl)phosphinyl]-3-(3,4-dichlorophenyl)-: 5..... 5..... 10..... 10.....	H <sub>2</sub> O..... H <sub>2</sub> O..... H <sub>2</sub> O..... H <sub>2</sub> O.....	Dip M..... Dip F..... Dip M..... Dip F.....	25 30 0 0	15 5 0 0	0 0 48 76
50882	Phosphoric triamide, hexamethyl- (hempa): 0.15..... .2.....	..... .....	Fed M..... Fed M.....	0 4	0 0	25 5
50918	Phosphorothioic triamide, hexamethyl-, 2.....	H <sub>2</sub> O.....	Dip F.....	(2)	...	80
51162	Phosphoric triamide, 2.....	H <sub>2</sub> O.....	Dip M.....	99	31	2
51256	Phosphinic amide, <i>P,P</i> -bis(1-aziridinyl)- <i>N</i> -isopropyl-: 2..... 2.....	H <sub>2</sub> O..... H <sub>2</sub> O.....	Dip M..... Dip F.....	0 (2)	0 ...	84 72
51904	1,3-Propanediol, dimethanesulfonate: 0.2..... .25..... .25..... 1..... 1.....	..... ..... ..... ..... .....	Fed M..... Fed M..... Fed F..... Fed M..... Fed F.....	96 0 (2) (2) (2)	27 0 ... ... ...	0 80 84 84 84
51959	Ethylenediamine, 1,2-diphenyl-, sulfate (1:1), 0.5.....	MeOH.....	Dip M.....	98	27	45



52100	Benzimidazole, 2-chloro-5-nitro-, 1	.....	Fed	F	.....	(2)	...	64
52484	Ammonium, ethyl[4-[ <i>p</i> -[ethyl( <i>m</i> -sulfofenyl)amino]- <i>o</i> -sulfofenyl]benzylidene]-2,5-cyclohexadien-1-ylidene] ( <i>m</i> -sulfofenyl)hydroxide, inner salt, diammonium salt, 1	H <sub>2</sub> O .....	Dip	M	.....	96	33	2
52492	Aniline, 4,4'-thiodi-, 2	MeOH .....	Dip	F	.....	88	13	50
52502	Coumarin, 7-(dimethylamino)-4-methyl-, 1	H <sub>2</sub> O .....	Dip	F	.....	93	29	15
52505	<i>o</i> -Toluidine, 4-( <i>o</i> -tolylazo)-, 2	MeOH .....	Dip	M	.....	100	33	0
61034	Cadmium, bis(2,4-pentanedionato)-: 2	H <sub>2</sub> O .....	Dip	M	.....	(2)	...	40
	2	H <sub>2</sub> O .....	Dip	F	.....	(2)	...	36
61566	Phosphonothioic diamide, <i>P</i> , <i>P</i> -(1-azetidynyl)- <i>N</i> , <i>N</i> , <i>N</i> ', <i>N</i> '-tetramethyl-, 2	MeOH .....	Dip	M	.....	67	0	36
61581	Phosphinothioic amide, <i>P</i> , <i>P</i> -bis(1-aziridinyl)- <i>N</i> -ethyl-: 2	MeOH .....	Dip	M	.....	(2)	...	84
	2	MeOH .....	Dip	F	.....	(2)	...	76
61585	Phosphinothioic amide, <i>P</i> , <i>P</i> -bis(1-aziridinyl)- <i>N</i> -methyl-: 2	H <sub>2</sub> O .....	Dip	M	.....	0	0	74
	2	H <sub>2</sub> O .....	Dip	F	.....	(2)	...	70
61587	Phosphine sulfide, bis(1-aziridinyl)ethyl-: 2	MeOH .....	Dip	M	.....	0	0	52
	2	MeOH .....	Dip	F	.....	(2)	...	52
	.01	.....	Fed	M	.....	0	0	88
	.01	.....	Fed	F	.....	(2)	...	92
	.1	.....	Fed	M	.....	0	0	92
	.1	.....	Fed	F	.....	(2)	...	92
	.5	.....	Fed	M	.....	0	0	92
	.5	.....	Fed	F	.....	(2)	...	92
61934	Acetohydroxamic acid, <i>N</i> -methyl-: 0.5	.....	Fed	M	.....	77	16	0
	.5	.....	Fed	F	.....	100	14	0
	1	.....	Fed	M	.....	22	14	30
61977	Acrylamide, <i>N</i> , <i>N</i> '-propylidenebis-: 0.5	.....	Fed	M	.....	(2)	...	72
	.5	.....	Fed	F	.....	(2)	...	64
	1	.....	Fed	M	.....	(2)	...	76
	1	.....	Fed	F	.....	(2)	...	60

See footnotes at end of table.

TABLE 1.—Relative effectiveness of candidate chemosterilants on boll weevil hatch, adult emergence, and mortality in dipping and feeding tests. (1 replication of 25 pairs of weevils per test)—Continued

Entomology No. (ENT-)	Chemical and concentration (percent)	Solvent	Test and sex treated	Average hatch	Average adult emergence	Mortality after 14 days
				Percent	Percent	Percent
EMERGENCE REDUCED TO 33-66 PERCENT						
5535	<i>m</i> -Dioxane, 5-methyl-4-[3,4-(methylenedioxy)phenyl]-, 0.01	.....	Fed M	78	60	0
12209	Ammonium, hexadecyltrimethyl bromide, 2 ...	H <sub>2</sub> O	Dip F	100	59	0
14931	<i>p</i> -Benzoquinone, 2-methyl-, 1	.....	Fed F	96	34	0
16630	Hydroquinone, 2,5-di- <i>tert</i> -butyl-, 2	.....	Fed F	98	50	0
24916	Phosphine sulfide, tris(1-aziridinyl)-, 2	MeOH	Dip F	86	54	20
25012	1,4-Butanediol, dimethanesulfonate, 2	DMSO	Dip M	100	60	40
26304	1-Propanol, 2,3-dibromo-:					
	1	.....	Fed M	44	40	36
	1	.....	Fed F	50	66	12
26388	Hydantoin, 1-[4-nitrofurfurylidene) amino]-, 1 ...	.....	Fed M	87	53	2
27439	4-Imidazolin-2-one, 2	H <sub>2</sub> O	Dip M	100	63	0
34148	3,7-Tridecadien-2-one, 11,12-epoxy-4,8,12-trimethyl-(mixed isomers), 0.0005	.....	Fed M	100	61	0
50233	Purine, 6-[( <i>o</i> -chlorobenzyl)thio]-, 0.5	MeOH	Dip M	81	53	0
50466	Acetotetroxamic acid, <i>N</i> -fluoren-2-yl-, 0.5	MeOH	Dip F	98	55	28
50761	Phosphinic acid, bis(1-aziridinyl)-ethyl ester, 2	H <sub>2</sub> O	Dip M	32	48	84
50882	Phosphoric triamide, hexamethyl- (hempa):					
	2	H <sub>2</sub> O	Dip M	82	54	1
	2	H <sub>2</sub> O	Dip F	100	59	0
	1	.....	Fed M	48	39	0
	.15	.....	Fed F	69	39	15
	.2	.....	Fed F	80	60	35

50387	1-Azirdinecarboxamide, <i>N,N</i> -vinylenebis-, ( <i>E</i> ):- 2 ..... 2 .....	MeOH ..... H <sub>2</sub> O .....	Dip M ..... Dip M .....	46 36	39 36	58 0
50991	Phosphonic diamide, <i>P</i> -(1-aziridinyl)- <i>N,N,N',N'</i> -tetramethyl-, 2 .....	H <sub>2</sub> O .....	Dip M .....	58	64	38
51272	Guanazole: 2 ..... 1 .....	MeOH ..... .....	Dip M ..... Fed F .....	100 100	61 48	4 2
51862	Boric acid, triphenyl ester: 2 ..... 1 .....	MeOH ..... .....	Dip M ..... Fed F .....	100 78	60 64	0 4
51904	1,3-Propanediol, dimethanesulfonate: 0.05 ..... .15 .....	..... .....	Fed M ..... Fed M .....	78 64	48 45	2 0
51959	Ethylenediamine, 1,2-diphenyl-, sulfate (1:1), 1..	.....	Fed M .....	100	62	0
51986	Semicarbazide, 1-benzoyl-3-thio-, 1 .....	MeOH .....	Dip M .....	88	58	5
52055	Imidazole, 5-(benzylthio)-1-methyl-4-nitro-, 0.5 ..	MeOH .....	Dip M .....	100	60	0
52068	Purine, 6-(phenylthio)-, 0.5 .....	.....	Fed F .....	96	40	1
52102	Phenol, <i>m</i> -(salicylideneamino)-, 2 .....	DMSO .....	Dip M .....	75	62	32
52129	2-Norbornanamine, monohydrochloride: 2 ..... 2 .....	H <sub>2</sub> O ..... H <sub>2</sub> O .....	Dip M ..... Dip F .....	76 100	56 47	5 0
52484	Ammonium, ethyl[4-[ <i>p</i> -[ethyl( <i>m</i> -sulfo benzyl)- amino]- $\alpha$ -(sulfo phenyl)-benzylidene]- 2,5-cyclohexadien-1-ylidene] ( <i>m</i> -sulfo benzyl)- hydroxide, inner salt, diammonium salt: 1 ..... 1 .....	..... .....	Fed M ..... Fed F .....	95 73	66 47	8 0
52492	Aniline, 4,4'-thiodi:- 2 ..... .1 ..... .1 .....	MeOH ..... ..... .....	Dip M ..... Fed M ..... Fed F .....	100 93 83	60 42 63	25 40 0
52495	Aniline, 4,4'-methylenedi-, dihydrochloride: 2 ..... 2 .....	H <sub>2</sub> O ..... H <sub>2</sub> O .....	Dip M ..... Dip F .....	100 100	58 53	0 0

See footnotes at end of table.

TABLE 1.—Relative effectiveness of candidate chemosterilants on boll weevil hatch, adult emergence, and mortality in dipping and feeding tests. (1 replication of 25 pairs of weevils per test)—Continued

Entomology No. (ENT-)	Chemical and concentration (percent)	Solvent	Test and sex treated	Average hatch	Average adult emergence	Mortality after 14 days
				Percent	Percent	Percent
52497	1-Anthramine, 1	.....	Fed F	100	48	5
52505	<i>o</i> -Toluidine, 4- ( <i>o</i> -tolylazo)-:					
	1	MeOH	Dip M	53	35	0
	1	.....	Fed F	96	41	17
60131	Melamine, N <sup>2</sup> ,N <sup>4</sup> ,N <sup>6</sup> -trichloro-, 0.5	.....	Fed F	100	57	0
60242	Phenazine, 3-amino-6- (dimethylamino)-					
	2-methyl-, monohydrochloride:					
	2	H <sub>2</sub> O	Dip F	90	93	2
	.5	.....	Fed M	100	59	38
61285	1-Adamantanol, 2	MeOH	Dip F	100	40	22
61530	Ammonium, trimethyl purin-6-yl- hydroxide, inner salt:					
	2	H <sub>2</sub> O	Dip M	98	40	10
	2	H <sub>2</sub> O	Dip F	100	60	2
61566	Phosphonothioic diamide, P- (1-azetidiny)- N,N,N'-tetramethyl-, 2	MeOH	Dip F	71	63	0
61587	Phosphine sulfide, bis (1-aziridiny)ethyl-, 2	MeOH	Dip M	72	40	45
61934	Acetohydroxamic acid, N-methyl-, 1	.....	Fed F	50	50	38
61946	Isoquinaldic acid, 2	H <sub>2</sub> O	Dip M	100	59	0
70348	2-Dodecenoic acid, 7,11-dichloro-3,7,11- trimethyl-, ethyl ester, (E)-, 0.5	.....	Fed M	44	61	0
70351	2-Octene, 6,7-epoxy-3,7-dimethyl-1-(2- propynyloxy)-, 0.5	.....	Fed M	92	40	0
329	Phthalic acid, diethyl ester:					
	2	MeOH	Dip M	100	100	0
	2	MeOH	Dip F	100	86	0
	1	.....	Fed M	96	100	0
	1	.....	Fed F	92	91	0

EMERGENCE REDUCED TO 66-100 PERCENT

754	Benzophenone:	2	.....	MeOH	.....	Dip M	.....	64	95	6
		2	.....	MeOH	.....	Dip F	.....	100	100	2
		1	.....	.....	.....	Fed M	.....	96	81	0
		1	.....	.....	.....	Fed F	.....	84	100	30
2546	Furil:	2	.....	MeOH	.....	Dip M	.....	100	100	0
		1	.....	.....	.....	Fed M	.....	94	91	8
		1	.....	.....	.....	Fed F	.....	96	100	12
3117	Phenethylamine:	2	.....	MeOH	.....	Dip M	.....	100	100	2
		2	.....	MeOH	.....	Dip F	.....	100	86	0
		1	.....	.....	.....	Fed M	.....	100	88	2
		1	.....	.....	.....	Fed F	.....	100	100	14
3357	1-Butanol, 2-amino-:	2	.....	H <sub>2</sub> O	.....	Dip M	.....	100	100	0
		2	.....	H <sub>2</sub> O	.....	Dip F	.....	100	100	0
		.5	.....	.....	.....	Fed M	.....	100	85	6
		.5	.....	.....	.....	Fed F	.....	81	98	2
5535	m-Dioxane, 5-methyl-4-[3,4-(methylenedioxy)phenyl]-:	2	.....	MeOH	.....	Dip M	.....	78	100	26
		2	.....	MeOH	.....	Dip F	.....	100	100	30
		.01	.....	.....	.....	Fed F	.....	78	60	0
12133	Acetophenone, 4'-hydroxy-:	2	.....	MeOH	.....	Dip M	.....	100	65	0
		2	.....	MeOH	.....	Dip F	.....	100	90	0
		1	.....	.....	.....	Fed M	.....	86	100	0
		1	.....	.....	.....	Fed F	.....	88	69	30
12209	Ammonium, hexadecyltrimethyl____bromide:	2	.....	H <sub>2</sub> O	.....	Dip M	.....	93	100	0
		.125	.....	.....	.....	Fed M	.....	84	100	8
		.125	.....	.....	.....	Fed F	.....	83	99	0
14653	2-Propanol, 1-amino-:	2	.....	H <sub>2</sub> O	.....	Dip M	.....	84	100	22
		2	.....	H <sub>2</sub> O	.....	Dip F	.....	80	67	2
		.1	.....	.....	.....	Fed M	.....	96	100	0
		.1	.....	.....	.....	Fed F	.....	96	95	0

See footnotes at end of table.



TABLE 1.—*Relative effectiveness of candidate chemosterilants on boll weevil hatch, adult emergence, and mortality in dipping and feeding tests. (1 replication of 25 pairs of weevils per test)*—Continued

Entomology No. (ENT-)	Chemical and concentration (percent)	Solvent	Test and sex treated	Average hatch		Average adult emergence		Mortality after 14 days	
				Percent		Percent		Percent	
14879	Carbanilic acid, isopropyl ester:		Fed M	100	84	4			
			Fed F	100	81	8			
			Fed M	100	100	0			
			Fed F	100	81	28			
			Fed M	86	81	0			
			Fed F	95	67	2			
14931	<i>p</i> -Benzoquinone, 2-methyl-:		Fed M	95	82	4			
			Fed M	99	76	42			
			Fed F	100	88	0			
15229	Anthranilic acid, 5-chloro-:	MeOH	Dip M	92	96	4			
			Fed M	100	100	0			
			Fed F	100	73	0			
15365	Hydrazobenzene:	MeOH	Dip M	100	100	0			
			Dip F	100	95	0			
			Fed M	100	100	32			
			Fed F	100	100	0			
16630	Hydroquinone, 2,5-di- <i>tert</i> -butyl-:	MeOH	Dip M	90	91	6			
			Fed M	100	100	0			
			Fed F	100	100	12			
19187	Tartar emetic:	H <sub>2</sub> O	Dip M	95	100	10			
			Dip F	100	100	14			
22596	2-Pyridinethiol, 1-oxide, sodium salt:		Fed M	99	100	44			
			Fed F	66	88	48			
			Dip M	100	90	0			
			Dip M	75	90	0			
			Dip M	75	90	0			

23427	Pseudoarea, 2-(2-aminoethyl)-2-thio-, dihydrobromide:	1 .....	H <sub>2</sub> O .....	Dip M .....	100	10
		1 .....	H <sub>2</sub> O .....	Dip F .....	100	15
		2 .....	H <sub>2</sub> O .....	Dip M .....	100	20
		2 .....	H <sub>2</sub> O .....	Dip F .....	100	20
		4 .....	H <sub>2</sub> O .....	Dip M .....	100	5
		4 .....	H <sub>2</sub> O .....	Dip F .....	100	0
		.5 .....	.....	Fed M .....	100	8
		.5 .....	.....	Fed F .....	97	0
		1 .....	.....	Fed M .....	87	0
		1 .....	.....	Fed F .....	46	0
24112	2-Picoline, 6-amino-:	2 .....	H <sub>2</sub> O .....	Dip M .....	100	0
		2 .....	H <sub>2</sub> O .....	Dip F .....	100	0
		1 .....	.....	Fed M .....	100	0
		1 .....	.....	Fed F .....	96	0
24809	1,4-Diazabicyclo[2.2.2]octane:	2 .....	H <sub>2</sub> O .....	Dip M .....	100	0
		2 .....	H <sub>2</sub> O .....	Dip F .....	84	0
		1 .....	.....	Fed M .....	90	0
		1 .....	.....	Fed F .....	92	22
24916	Phosphine sulfide, tris(1-aziridinyl)-:	0.1 .....	H <sub>2</sub> O .....	Dip M .....	100	0
		.1 .....	H <sub>2</sub> O .....	Dip F .....	100	0
		.2 .....	H <sub>2</sub> O .....	Dip M .....	100	0
		.2 .....	H <sub>2</sub> O .....	Dip F .....	100	0
		2 .....	MeOH .....	Dip M .....	79	20
26388	Hydantoin, 1-[(5-nitrofurfurylidene)amino]-:	0.5 .....	MeOH .....	Dip M .....	98	45
		.5 .....	MeOH .....	Dip F .....	77	25
		1 .....	MeOH .....	Dip M .....	85	35
		1 .....	MeOH .....	Dip F .....	79	60
		2 .....	MeOH .....	Dip M .....	100	15
		2 .....	MeOH .....	Dip F .....	79	50
		1 .....	.....	Fed F .....	93	10

See footnotes at end of table.

TABLE 1.—*Relative effectiveness of candidate chemosterilants on boll weevil hatch, adult emergence, and mortality in dipping and feeding tests. (1 replication of 25 pairs of weevils per test)*—Continued

Entomology No. (ENT-)	Chemical and concentration (percent)	Solvent	Test and sex treated	Average hatch	Average adult emergence	Mortality after 14 days
				Percent	Percent	Percent
26685	Triethylamine, 2'-chloro-1,1'-dimethyl-, monohydrochloride:					
		0.5.....	H <sub>2</sub> O.....	Dip M.....	100	100
		.5.....	H <sub>2</sub> O.....	Dip F.....	91	77
		1.....	H <sub>2</sub> O.....	Dip M.....	100	100
		1.....	H <sub>2</sub> O.....	Dip F.....	84	100
		2.....	H <sub>2</sub> O.....	Dip M.....	99	79
		2.....	H <sub>2</sub> O.....	Dip F.....	100	89
27439	4-Imidazolin-2-one:	.1.....	.....	Fed M.....	66	92
		1.....	H <sub>2</sub> O.....	Dip M.....		
		1.....	H <sub>2</sub> O.....	Dip F.....	100	79
30023	Benzophenone, phenylhydrazone:	2.....	H <sub>2</sub> O.....	Dip F.....	100	92
		2.....	H <sub>2</sub> O.....	Dip F.....	100	84
		1.....	MeOH.....	Dip M.....	100	85
		2.....	MeOH.....	Dip F.....	100	68
		1.....	.....	Fed M.....	100	94
31295	1,3-Butanedione, 4,4,4-trifluoro-1-(2-thienyl)-:	1.....	.....	Fed F.....	100	94
		2.....	.....	Dip M.....		2
		2.....	.....	Dip F.....		2
		1.....	.....	Fed M.....		16
		1.....	.....	Fed F.....		0
34148	3,7-Tridecadien-2-one, 11,12-epoxy-4,8,12-trimethyl- (mixed isomers):	2.....	MeOH.....	Dip M.....	87	93
		2.....	MeOH.....	Dip F.....	100	71
		1.....	.....	Fed M.....	96	100
		1.....	.....	Fed F.....	90	100
		0.0005.....	.....	Fed F.....		32
34254	3,7-Tetradecadien-2-one, 11,12-epoxy-8-ethyl-4,12-dimethyl- (mixed isomers):	.001.....	.....	Fed M.....	96	100
		.001.....	.....	Fed F.....	83	0
		.001.....	.....	Fed F.....	100	0
34254	3,7-Tetradecadien-2-one, 11,12-epoxy-8-ethyl-4,12-dimethyl- (mixed isomers):	0.35.....	.....	Fed F.....		10
		.7.....	.....	Fed M.....	100	95
			.....	Fed M.....	100	26



TABLE 1.—*Relative effectiveness of candidate chemosterilants on boll weevil hatch, adult emergence, and mortality in dipping and feeding tests. (1 replication of 25 pairs of weevils per test)*—Continued

Entomology No. (ENT-)	Chemical and concentration (percent)	Solvent	Test and sex treated	Average hatch	Average adult emergence	Mortality after 14 days
				Percent	Percent	Percent
51862	Boric acid, triphenyl ester: 2 .....	MeOH .....	Dip F .....	100	95	0
			Fed M .....			
51959	Ethylenediamine, 1,2-diphenyl-, sulfate (1:1), 2 .....	MeOH .....	Dip M .....	100	97	10
51964	2-Pyridinecarbamic acid, ethyl ester: 0.5 .....	MeOH .....	Dip M .....	91	80	0
			Dip F .....			
			Dip M .....			
			Dip F .....			
			Fed M .....			
			Fed F .....			
51968	<i>m</i> -Benzenedicarbamic acid, diethyl ester: 1 .....	MeOH .....	Dip M .....	84	93	0
			Dip F .....			
			Dip M .....			
			Dip F .....			
			Dip M .....			
			Dip F .....			
			Dip M .....			
			Dip F .....			
			Fed M .....			
			Fed F .....			
			Fed M .....			
			Fed F .....			
			Fed M .....			
			Fed F .....			
51986	Semicarbazide, 1-benzoyl-3-thio-: 1 .....	MeOH .....	Dip F .....	100	93	35
			Dip M .....			
			Dip M .....			
			Dip F .....			
			Fed M .....			
			Fed F .....			
			Fed M .....			
			Fed F .....			
			Fed M .....			
			Fed F .....			
			Fed M .....			
			Fed F .....			
			Fed M .....			
			Fed F .....			
			Fed M .....			



51996	Guanidine, [( <i>p</i> -hydroxybenzylidene)amino]-:- 0.1 ..... .1 ..... .25 ..... .25 ..... 1 ..... 1 .....	Fed M ..... Fed F ..... Fed M ..... Fed F ..... Fed M ..... Fed F .....	98 93 84 96 92 82	100 100 100 100 100 93	0 12 16 0 8 4	
52055	Imidazole,5-(benzylthio)-1-methyl-4-nitro:- 0.5 ..... 1 ..... 2 ..... .125 ..... .125 ..... .25 ..... .25 ..... .5 ..... .5 ..... .75 ..... .75 .....	MeOH ..... MeOH ..... MeOH ..... ..... ..... ..... ..... ..... ..... ..... .....	Dip F ..... Dip M ..... Dip F ..... Fed M ..... Fed F ..... Fed M ..... Fed F ..... Fed M ..... Fed F .....	100 100 99 100 91 96 80 100 91 100 96	100 93 90 100 100 100 100 100 100 100 100	0 0 0 24 0 0 24 0 24 24 0 24
52068	Purine, 6-(phenylthio)-:- 0.5 ..... 1 ..... 1 .....	..... ..... .....	Fed M ..... Fed F ..... Fed F .....	86 90 100	1 17 5	
52100	Benzimidazole, 2-chloro-5-nitro:- 0.5 ..... .5 ..... 1 ..... 1 ..... 2 ..... 2 ..... 1 .....	MeOH ..... MeOH ..... MeOH ..... MeOH ..... MeOH ..... MeOH ..... .....	Dip M ..... Dip F ..... Dip M ..... Dip F ..... Dip M ..... Dip F ..... Fed M .....	100 100 100 100 100 100 100	5 0 10 0 0 0 68	
52102	Phenol, <i>m</i> -(salicylideneamino)-:- 1 ..... 2 ..... 1 .....	MeOH ..... MeOH ..... .....	Dip M ..... Dip F ..... Fed M .....	66 73 100	5 0 0	

TABLE 1.—Relative effectiveness of candidate chemosterilants on boll weevil hatch, adult emergence, and mortality in dipping and feeding tests. (1 replication of 25 pairs of weevils per test)—Continued

Entomology No. (ENT-)	Chemical and concentration (percent)	Solvent	Test and sex treated	Average hatch	Average adult emergence	Mortality after 14 days
				Percent	Percent	Percent
52108	Purine, 2-(butylamino)-6-(methylamino)-:					
	0.5 .....	MeOH .....	Dip M .....	98	100	0
	.5 .....	MeOH .....	Dip F .....	93	100	0
	1 .....	MeOH .....	Dip M .....	87	93	0
	1 .....	MeOH .....	Dip F .....	98	100	15
	2 .....	MeOH .....	Dip M .....	84	100	15
	2 .....	MeOH .....	Dip F .....	82	80	0
	.1 .....	.....	Fed M .....	98	100	0
	.1 .....	.....	Fed F .....	98	100	6
	.25 .....	.....	Fed M .....	100	100	2
	.25 .....	.....	Fed F .....	100	93	2
	.5 .....	.....	Fed M .....	96	100	6
	.5 .....	.....	Fed F .....	100	100	2
	1 .....	.....	Fed M .....	98	100	0
	1 .....	.....	Fed F .....	100	100	0
52129	2-Norbomanamine, monohydrochloride:					
	1 .....	H <sub>2</sub> O .....	Dip M .....	100	100	0
	1 .....	H <sub>2</sub> O .....	Dip F .....	100	95	0
	.05 .....	.....	Fed M .....	100	88	0
	.05 .....	.....	Fed F .....	100	100	0
	.1 .....	.....	Fed M .....	100	100	0
	.1 .....	.....	Fed F .....	100	100	0
52138	Guanidine, amino-, compound with carbonic acid (1:1):					
	2 .....	MeOH .....	Dip M .....	100	76	0
	2 .....	MeOH .....	Dip F .....	97	88	14
	1 .....	.....	Fed M .....	100	100	0
	1 .....	.....	Fed F .....	74	89	4
52396	Methane, triiodo-:					
	0.5 .....	DMSO .....	Dip M .....	100	100	0
	.5 .....	DMSO .....	Dip F .....	100	100	0
	1 .....	DMSO .....	Dip M .....	100	100	0
	1 .....	DMSO .....	Dip F .....	100	100	0
	2 .....	DMSO .....	Dip M .....	100	85	0
	2 .....	DMSO .....	Dip F .....	100	92	0

52450	Anthranilic acid, 4-chloro:- 0.5..... .5..... 1..... 1..... 2..... 2..... 1..... 1.....	DMSO..... DMSO..... DMSO..... DMSO..... DMSO..... DMSO..... ..... .....	Dip M..... Dip F..... Dip..... Dip F..... Dip M..... Fed M..... Fed F.....	91 81 96 85 64 94 92 87	100 87 94 100 100 68 84	0 0 5 0 5 4 4
52495	Aniline, 4,4'-methylenedi-, dihydrochloride: 1..... 1..... 1..... 1.....	H <sub>2</sub> O..... H <sub>2</sub> O..... ..... .....	Dip M..... Dip F..... Fed M..... Fed F.....	100 79 96 61	84 75 100	0 0 0
52497	1-Anthramine: 0.5..... .5..... 1..... 1..... 1.....	MeOH..... MeOH..... MeOH..... MeOH..... .....	Dip M..... Dip F..... Dip M..... Dip F..... Fed M.....	96 80 86 76 86	100 84 79 100 68	0 0 0 0
52502	Coumarin, 7-(dimethylamino)-4-methyl:- 1..... 2..... 2..... 4..... 4..... 1.....	H <sub>2</sub> O..... H <sub>2</sub> O..... H <sub>2</sub> O..... H <sub>2</sub> O..... .....	Dip M..... Dip M..... Dip F..... Dip M..... Dip F..... Fed M.....	84 80 95 66 89 100	100 86 100 86 71 100	0 10 15 10 5 0
52505	<i>o</i> -Toluidine, 4-( <i>o</i> -tolylazo):- 1..... 2..... 2..... 4..... 4..... 1.....	MeOH..... MeOH..... MeOH..... MeOH..... .....	Dip F..... Dip M..... Dip F..... Dip M..... Dip F..... Fed M.....	43 71 68 70 32 80	71 100 100 100 100 100	7 17 17 2 0 13
52766	Benzenesulfonamide, 2,5-dichloro- <i>N</i> -( <i>2,4</i> -dinitro-1-naphthyl):- 2..... 2.....	Acetone..... ..... do .....	Dip M..... Dip F.....	100 88	100 92	0 0
60128	<i>s</i> -Triazine, 4,6-diamino-1,2-dihydro-2,2-dimethyl-1-(2-naphthyl)-, monohydrochloride: 0.5..... .5.....	H <sub>2</sub> O..... H <sub>2</sub> O.....	Dip M..... Dip F.....	86 100	100 100	2 2

See footnotes at end of table.

TABLE 1.—Relative effectiveness of candidate chemosterilants on boll weevil hatch, adult emergence, and mortality in dipping and feeding tests. (1 replication of 25 pairs of weevils per test)—Continued

Entomology No. (ENT-)	Chemical and concentration (percent)	Solvent	Test and sex treated	Average hatch	Average adult emergence	Mortality after 14 days
				Percent	Percent	Percent
60131	Melamine, $N^2N^4N^6$ -trichloro-, 1.....	.....	Fed M .....	87	100	0
60171	Piperidine, 1-methyl-, 1-oxide, picrate (1:1): 2 .....	H <sub>2</sub> O .....	Dip M .....	62	100	32
	2 .....	H <sub>2</sub> O .....	Dip F .....	100	100	4
60227	Melamine, $N^2N^2$ -diethyl- $N^4N^4N^6N^6$ -tetramethyl-, monohydrochloride: 2 .....	H <sub>2</sub> O .....	Dip M .....	100	100	6
	2 .....	H <sub>2</sub> O .....	Dip F .....	100	95	78
	1 .....	.....	Fed M .....	79	78	4
	1 .....	.....	Fed F .....	91	100	20
60242	Phenazine, 3-amino-6-(dimethylamino)-2-methyl-, monohydrochloride: 2 .....	H <sub>2</sub> O .....	Dip M .....	90	93	2
	.5 .....	.....	Fed F .....	100	100	62
60372	Sodium tetrabutoxyborate: 2 .....	MeOH .....	Dip M .....	77	100	0
	2 .....	MeOH .....	Dip F .....	66	100	10
61177	Phosphonic diamide, $N,N,N',N'$ -tetramethyl- $P$ -(4-methyl-1-piperidino)-: 2 .....	H <sub>2</sub> O .....	Dip M .....	100	100	0
	2 .....	H <sub>2</sub> O .....	Dip F .....	100	100	0
	.1 .....	.....	Fed M .....	86	86	0
	.1 .....	.....	Fed F .....	92	100	4
	.5 .....	.....	Fed M .....	62	91	0
	.5 .....	.....	Fed F .....	80	100	4
61285	1-Adamantanol: 1 .....	MeOH .....	Dip M .....	100	100	3
	1 .....	MeOH .....	Dip F .....	100	97	17
	2 .....	MeOH .....	Dip M .....	100	69	7
	4 .....	MeOH .....	Dip F .....	100	86	12
	4 .....	MeOH .....	Dip M .....	100	80	27
	1 .....	.....	Fed M .....	78	92	0
	1 .....	.....	Fed F .....	95	83	0

61433	Ammonium, hexamethylenebis[trimethyl chloride]: 2 ..... 2 ..... .25 ..... .25 .....	H <sub>2</sub> O ..... H <sub>2</sub> O ..... ..... .....	Dip M ..... Dip F ..... Fed M ..... Fed F .....	91 ..... 100 ..... 100 ..... 100 .....	86 ..... 93 ..... 100 ..... 100 .....	0 ..... 2 ..... 10 ..... 12 .....
61453	s-Triazin-2-ol, 4,6-bis(dimethylamino), compound with mercuric chloride (1:1): 2 ..... 2 ..... .001 ..... .001 ..... .01 ..... .01 ..... .1 ..... .1 ..... .5 ..... .5 .....	MeOH ..... MeOH ..... ..... ..... ..... ..... ..... ..... ..... .....	Dip M ..... Dip F ..... Fed M ..... Fed F ..... Fed M ..... Fed F ..... Fed M ..... Fed F ..... Fed M ..... Fed F .....	86 ..... 100 ..... 95 ..... 100 ..... 100 ..... 100 ..... 100 ..... 100 ..... 99 ..... 78 ..... 100 .....	100 ..... 100 ..... 100 ..... 100 ..... 100 ..... 100 ..... 100 ..... 100 ..... 100 ..... 100 .....	0 ..... 0 ..... 4 ..... 0 ..... 0 ..... 0 ..... 0 ..... 0 ..... 44 ..... 24 ..... 40 .....
61527	Ammonium, 2-butylenebis[trimethyl chloride]: 2 ..... 2 .....	MeOH ..... MeOH .....	Dip M ..... Dip F .....	82 ..... 100 .....	95 ..... 100 .....	6 ..... 0 .....
61567	Phosphoric triamide, N,N'''-methylenebis [pentamethyl]-:- 0.5 ..... .5 .....	MeOH ..... MeOH .....	Dip M ..... Dip F .....	100 ..... 100 .....	100 ..... 100 .....	20 ..... 20 .....
61580	Phosphinothioic amide, P,P-bis(1-aziridinyl)-N-propyl:- 0.125 ..... .125 ..... .25 ..... .25 .....	..... ..... ..... .....	Fed M ..... Fed F ..... Fed M ..... Fed F .....	100 ..... 95 ..... 87 ..... 88 .....	100 ..... 100 ..... 95 ..... 100 .....	8 ..... 28 ..... 16 ..... 28 .....
61946	Isoquinaldic acid: 2 ..... .1 ..... .1 ..... .2 ..... .2 .....	H <sub>2</sub> O ..... ..... ..... ..... .....	Dip F ..... Fed M ..... Fed F ..... Fed M ..... Fed F .....	100 ..... 100 ..... 100 ..... 100 ..... 100 .....	76 ..... 100 ..... 100 ..... 100 ..... 100 .....	28 ..... 34 ..... 0 ..... 10 ..... 0 .....



TABLE 1.—Relative effectiveness of candidate chemosterilants on boll weevil hatch, adult emergence, and mortality in dipping and feeding tests. (1 replication of 25 pairs of weevils per test)—Continued

Entomology No. (ENT-)	Chemical and concentration (percent)	Solvent	Test and sex treated	Average hatch Percent	Average adult emergence Percent	Mortality after 14 days Percent
61948	1,3,4-Thiadiazole, 2,2'-dithiobis[5-amino]-:					
2	.....	MeOH .....	Dip M .....	98	86	32
2	.....	MeOH .....	Dip F .....	100	100	8
.1	.....	.....	Fed M .....	100	100	0
.1	.....	.....	Fed F .....	100	100	10
.2	.....	.....	Fed M .....	93	100	0
.2	.....	.....	Fed F .....	93	100	10
70159	Ethane, 1-[(6,7-epoxy-3,7-dimethyl-2-octenyl)- oxy]-2-ethoxy-, (E)-:					
0.5	.....	H <sub>2</sub> O .....	Dip M .....	100	100	17
.5	.....	H <sub>2</sub> O .....	Dip F .....	100	100	7
1	.....	H <sub>2</sub> O .....	Dip M .....	100	100	7
1	.....	H <sub>2</sub> O .....	Dip F .....	100	100	32
.5	.....	.....	Fed M .....	100	100	4
.5	.....	.....	Fed F .....	100	100	12
1	.....	.....	Fed M .....	100	100	4
1	.....	.....	Fed F .....	100	100	0
70348	2-Dodecenoic acid, 7,11-dichloro-3,7,11-trimethyl- ethyl ester, (E)-:					
1	.....	MeOH .....	Dip M .....	86	90	0
1	.....	MeOH .....	Dip F .....	100	70	0
2	.....	MeOH .....	Dip M .....	91	86	0
2	.....	MeOH .....	Dip F .....	100	84	5
.5	.....	.....	Fed F .....	100	96	0
1	.....	.....	Fed M .....	86	96	0
1	.....	.....	Fed F .....	100	100	0

70349	Benzoic acid, <i>p</i> -[(1,5-dimethylhexyl)oxy]-, methyl ester:	1	.....	MeOH	.....	Dip	M	.....	79	99	0
		1	.....	MeOH	.....	Dip	F	.....	97	70	0
		2	.....	MeOH	.....	Dip	M	.....	84	100	0
		2	.....	MeOH	.....	Dip	F	.....	97	100	0
		.5	.....	.....	.....	Fed	M	.....	87	68	0
		.5	.....	.....	.....	Fed	F	.....	96	88	0
		1	.....	.....	.....	Fed	M	.....	100	100	0
		1	.....	.....	.....	Fed	F	.....	81	82	0
70350	2,6-Dodecadienoic acid, 11,11-epoxy-3,7,10,11-tetramethyl-, ethyl ester:	1	.....	MeOH	.....	Dip	M	.....	100	96	0
		1	.....	MeOH	.....	Dip	F	.....	91	84	0
		2	.....	MeOH	.....	Dip	M	.....	100	70	0
		2	.....	MeOH	.....	Dip	F	.....	98	90	0
		.5	.....	.....	.....	Fed	M	.....	100	84	0
		.5	.....	.....	.....	Fed	F	.....	100	100	0
		1	.....	.....	.....	Fed	M	.....	89	82	0
		1	.....	.....	.....	Fed	F	.....	100	92	0
70351	2-Octene, 6,7-epoxy-3,7-dimethyl-1-(2-propynyloxy)-:	1	.....	MeOH	.....	Dip	M	.....	100	72	0
		1	.....	MeOH	.....	Dip	F	.....	92	100	0
		2	.....	MeOH	.....	Dip	M	.....	97	76	0
		2	.....	MeOH	.....	Dip	F	.....	84	78	0
		.5	.....	.....	.....	Fed	M	.....	100	100	0
		1	.....	.....	.....	Fed	F	.....	100	100	0

<sup>1</sup> Treated male × untreated female in dipping tests.<sup>2</sup> No eggs laid.<sup>3</sup> Treated female × untreated male in feeding tests.

